10/589622

IAP6 Rec'd PCT/PTO 16 AUG 2006

Our Ref.: JJVC-141-PCT-US

English translation of Amendment under PCT Article 34

PCT/JP2005/000914

IAPS Rec'd PCT/PTO 16 AUG 2006

[0033]

The optical device avoids the influence of unnecessary light only on reflected sub-beams that are greatly affected by the unnecessary light, to thereby avoid an increase in the size of the operation circuit.

[0034]

In the optical device according to the present invention, the wavelength of an incident beam is close to one of the first wavelength of ~~790-nm band~~**780-nm band** and second wavelength of 660-nm band.

[0035]

The optical device is applicable to optical disks of the DVD (digital versatile disk) standard and optical disks of the CD (compact disk) standard.

[0036]

In the optical device according to the present invention, at least one of a light source for emitting light of the first wavelength and a light source for emitting light of the second wavelength is integrally formed on a substrate on which the light receiving element is arranged.

[0037]

In the optical device, at least one of the light sources is integrally formed on a substrate on which the light receiving element is arranged, to easily determine the wavelength of a beam.

[0038]

An optical pickup apparatus according to the present invention includes the above-mentioned optical device and a laser source for emitting light of the first wavelength and a laser source for emitting light of the second wavelength. Light from

the light sources irradiates an information recording medium, and reflected beams from the information recording medium are made incident to the optical device to read information from the information recording medium.

[0039]

In the optical pickup apparatus, when one of the light receiving regions is receiving an incident beam of one of the wavelengths, the operation unit carries out an operation according to an output signal from the one light receiving region and an output signal from another one of the light receiving regions, to detect an unnecessary light component and avoid the influence of the unnecessary light component.

[0040]

An optical pickup apparatus according to the present invention includes the above-mentioned optical device, a first laser source for emitting a laser beam of the first wavelength, a first diffraction grating for dividing the laser beam of the first wavelength from the first laser source into a main beam and two sub-beams, a second laser source arranged in the optical device, for emitting a laser beam of the second wavelength, and a second diffraction grating arranged in the optical device, for dividing the laser beam of the second wavelength from the second laser source into a main beam and two sub-beams. The laser beams emitted from the laser sources irradiate an information recording medium. Reflected beams from the information recording medium are made incident to the optical device. The reflected main beams from the information recording medium are used to read main information from the information recording medium. The reflected sub-beams from the information recording medium are used to read a tracking error signal from the information recording medium.

[0102]

In connection with an advancing direction of each sub-beam relative to a recording track on an optical disk, a leading sub-beam is the first sub-beam S1 and a trailing sub-beam is the second sub-beam S2. These reflected sub-beams are diffracted by the first and second regions 19L and 19R of the hologram element 19, to form the reflected sub-beams S1L, S1R, S2L, and S2R. As shown in Fig. 6, these reflected sub-beams maintain positional relationships with respect to the reflected main beams and are received by the corresponding light receiving faces.

[0103]

To detect a focus error signal, each of the reflected main beam receiving faces 20A, 20B, 21A, and 21B is divided in parallel into four sections. On the other hand, each of the reflected sub-beam receiving faces is not divided into sections because it is only required to totally detect the integrated quantity of light for each of the reflected sub-beams.

[0104]

Due to a diffraction principle, the hologram element 19 provides different diffraction angles for different wavelengths of transmitted light. Accordingly, the hologram element 19 diffracts a sub-beam of the second wavelength (~~**790-nm band**~~**780-nm band**) larger than a sub-beam of the first wavelength (650-nm band) that is shorter than the second wavelength. As shown in Fig. 6, the sub-beam of first wavelength is received on an inner side (closer to an optical axis) of a light receiving face, and the sub-beam of second wavelength is received on an outer side (farther from the optical axis) of the light receiving face. Depending on arriving positions of the sub-beams, the light receiving faces for the sub-beams are slightly inclined and are each

formed in a rectangular shape.

[0105]

The optical device 9 uses one of the two ±1st-order diffracted sub-beams provided by the hologram element 19. Between the light receiving faces 20A and 21A and between the light receiving faces 20B and 21B, there are sub-beam spots 50 that are not used in this embodiment.

[0106]

Figure 7(a) is a plan view showing states of reflected beams on the light receiving element of the optical device when the first-type optical disk (DVD-standard optical disk) is used and Fig. 7(b) is a plan view showing states of reflected beams on the light receiving element of the optical device when the second-type optical disk (CD-standard optical disk) is used.

[0107]

For the first-type optical disk (DVD-standard optical disk), the optical pickup apparatus employs the laser source of first wavelength to record or reproduce information. In this case, the optical device 9 receives, as shown in Fig. 7(a), a reflected main beam with the first to fourth light receiving faces 20A, 20B, 21A, and 21B, a reflected first sub-beam with the third and seventh light receiving faces 22 and 26, and a reflected second sub-beam with the fourth and eighth light receiving faces 23 and 27.

[0108]

For the second-type optical disk (CD-standard optical disk), the optical pickup apparatus employs the laser source of second wavelength to record or reproduce information. In this case, the optical device 9 receives, as shown in Fig. 7(b), a

reflected main beam with the first to fourth light receiving faces 20A, 20B, 21A, and 21B, a reflected first sub-beam with the fifth and ninth light receiving faces 24 and 28, and a reflected second sub-beam with the sixth and tenth light receiving faces 25 and 29.

[0132]

As explained above, a diffracted beam from the hologram element 19 in the optical device 9 is received by a light receiving face on the light receiving element 12 and is photoelectrically converted into a current. The same region of a diffractive optical element such as the hologram element 19 provides a different diffraction angle for an incident beam of a different wavelength because of a physical rule. As shown in Fig. 9(a), a reflected sub-beam of the first wavelength (650-nm band) used for the first-type optical disk (DVD-standard optical disk) forms a smaller diffraction angle than a reflected sub-beam of the second wavelength (780-nm band) used for the second-type optical disk (CD-standard optical disk) and irradiates a spot closer to a spot of a 0th-order transmitted beam. As shown in Fig. 9(b), the reflected sub-beam of second wavelength forms a larger diffraction angle than the reflected sub-beam of first wavelength and irradiates a spot away from the spot of the 0th-order transmitted beam.

[0133]

In consideration of the wavelength dependence of a diffraction angle, the optical device 9 receives a reflected sub-beam of the first wavelength and a reflected sub-beam of the second wavelength at different light receiving regions A and B, respectively.

[0134]

Problems to be caused by unnecessary light will be explained.

[0135]

Figure 10(a) is a perspective view showing unnecessary light irradiating the light receiving element 12, Fig. 10(b) is a plan view showing the same, and Fig. 10(c) is a waveform showing a detection signal.

[0136]

As explained above, a two-layer disk or an object lens used for each of the first- and second-type optical disks produces in principle unnecessary light together with proper reflected beams used for reproducing recorded information. The unnecessary light does not focus on a point on a disk, and therefore, reflected unnecessary light widely scatters over the light receiving element 12 as shown in Figs. 10(a) and 10(b).

[0137]

In addition to a detection signal representative of a proper reflected beam, the unnecessary light component is photoelectrically converted into a signal, which is added to the detection signal. The unnecessary light is not modulated with information of disk pits due to the above-mentioned reason, and therefore, is detected as a substantially constant DC component.

[0138]

The unnecessary light component is affected by an inclination of the disk, a change in the intensity of recording/reproducing light, an intensity distribution of branched beams, a change due to lens shift, and the like. However, the proportion of the unnecessary light component relative to the proper reflected beam is substantially constant. Accordingly, to avoid the influence of the unnecessary light, subtracting an electric constant value is insufficient. It is necessary to take a measure in consideration of changes in the intensity and distribution of light.

[0139]

Figure 11(a) is a plan view showing a principle of a measure (for the first-type optical disk) to cope with unnecessary light in the optical device 9 and Fig. 11(b) shows

related waveforms.

[0140]

An irradiating state of unnecessary light will be studied. In Fig. 11(a), the first and second light receiving regions A and B have the same area and receive the same quantity of light~~ when the zones A and B are very close to each other~~.

[0141]

When a beam of the first wavelength is used for reproduction, an output from the light receiving zone for a beam of the second wavelength that is not used for the first-wavelength reproduction may be subtracted from a main detection output by a subtracter 34 serving as an operation unit, to substantially completely remove an unnecessary light component from the detection signal as shown in Fig. 11(b).

[0142]

When using the first-type optical disk, the optical device 9 may employ the subtracter 34 to provide an operation output of (A - B). Here, a detection output from the light receiving zone A for receiving a reflected sub-beam of the first wavelength is "A" and a detection output from the light receiving zone B for receiving a reflected sub-beam of the second wavelength is "B."

[0143]

Figure 12(a) is a plan view showing a principle of a measure (for the second-type optical disk) to cope with unnecessary light in the optical device 9 and Fig. 12(b) shows a related waveform.

[0144]

When using the second-type optical disk, the subtracter 34 provides an operation output (B - A) to remove an unnecessary light component.

[0145]

Only by inverting the polarity of an operation output of the subtracter 34, an influence of unnecessary light can be avoided for both the first- and second-type optical disks.

[0146]

The first light receiving zone A and second light receiving zone B are not limited to those for receiving reflected sub-beams. They may be those for receiving reflected main beams, the zones being divided depending on wavelengths to be used. In this case, the optical device 9 can avoid the influence of unnecessary light not only for reflected sub-beams but also for reflected main-beams.

[0147]

The first light receiving zone to receive reflected light of the first wavelength and the second light receiving zone to receive reflected light of the second wavelength are substantially the same in the size of a light receiving area. This means that an intensity difference between incident beams of the different wavelengths is adjusted by adjusting the areas of the light receiving zones so that the intensity of received unnecessary light will be the same without regard to the wavelength thereof. The light receiving zones may have light receiving faces of different shapes if the areas of the light receiving faces are substantially equal to one another in consideration of intensity difference between incident light of the different wavelengths.

[0154]

To secure recording light power for a recordable optical disk (recordable DVD), the light quantity ratio of a sub-beam to main beam is usually set to a large value, for example, 1:10 up to 1:20, typically 1:16.

[0155]

In this sort of optical system, even if the influence of an unnecessary light component on reflected main beams is ignorable, a flare caused by the main beams irradiates the light receiving zones for receiving reflected sub-beams. In this case, the flare that influences the reflected sub-beams has an intensity 10 to 20 times greater than that of the sub-beams.

[0156]

Accordingly, detection outputs from reflected main beams may be provided without the use of the above-mentioned cancel signal so as to simplify a circuit system. Only for reflected sub-beams on which unnecessary light gives an unignorable influence, the above-mentioned cancel signal may be generated and used.

[0157]

Only for the light receiving zones A and B to receive reflected sub-beams, adjacent light receiving zones of the same area are formed as shown in Fig. 14(a), and according to a difference between detection outputs of these light receiving zones, the influence of unnecessary light will be omitted. In Fig. 14(b), each of operation outputs S1' and S2' from the subtracters 34 is multiplied by a constant k, to provide operation outputs kS1' and kS2' having sufficient amplitudes.

[0158]

As explained above, the optical device 9 according to the present invention can

suppress the influence of unnecessary light on reflected sub-beams whose intensity is weak and reduce an offset without increasing the size of an operation circuit.

[0159]

The structures of the hologram element 19 and light receiving element 12 of the optical device according to the present invention used to obtain a tracking error signal TE and focus error signal (FE) are not limited to those mentioned above. They may be replaced with any other known structures.

[0160]

In the optical device 9, each of the first light receiving faces 20A and 20B and second light receiving faces 21A and 21B for receiving reflected main beams may be divided in parallel into three sections. When recording information to an optical disk, each three sections are sufficient to obtain a push-pull signal (SubPP), or a push-pull signal for a main beam used to find a tracking error signal (TE(DPP)) based on a differential push-pull method. When reproducing information from an optical disk according to a phase differential (DPD), it is necessary to divide each of the first light receiving faces 20A and 20B and second light receiving faces 21A and 21B for receiving reflected main beams into four sections in parallel.